OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

December 18 - December 24, 1998

Summary 98-51

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EVENTS

1. IMPROPERLY ASSEMBLED STEAM TRAPS RECEIVED FROM DISTRIBUTOR

On December 4, 1998, at the West Valley Site, a facility manager reported that an Armstrong 880T steam trap was improperly assembled, affecting its operation. The internal configuration of the trap incorrectly included a riser that interfered with the proper operation of a thermic bucket that controls the release of air and water from the trap. Facility personnel contacted the trap manufacturer about the as-found configuration. The manufacturer agreed that the configuration of the trap was improper and that one of its distributors may have taken its parts and assembled them improperly. This event is important because proper steam trap operation is crucial in preventing condensate-induced water hammer, which can damage equipment and injure personnel. (OH-WV-WVNS-WVNSGEN-1998-0001)

Operators at the West Valley Site found the steam trap not functioning following restart from a system outage. Believing the line was plugged they flushed and drained it, with no success. Mechanics disassembled the trap, removed some debris, and returned it to service. The trap still did not function correctly and was disassembled a second time. A system engineer then found that the trap was equipped with a riser that interfered with the operation of the thermic bucket. The thermic bucket is an inverted bucket that includes a bimetallic (thermostatic) controlled auxiliary air vent for discharging large amounts of air on start-up of the system. The buildup of air inside the inverted bucket can interfere with trap operation. The riser is designed to help with the efficiency of the steam trap when a normal bucket is installed. A normal bucket has a small vent in its top that allows air to escape. Figure 1-1 shows the configuration of the 880T steam trap with the thermic bucket and the installed riser. Figure 1-2 shows the configuration of a typical inverted bucket trap with a normal bucket.

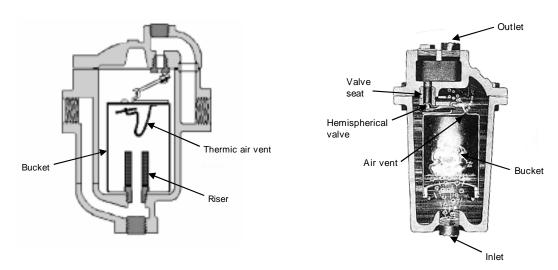


Figure 1-1. Steam Trap With Riser

Figure 1-2. Inverted Bucket Trap (Courtesy of Armstrong Machine Works)

Steam traps are used on steam systems to remove condensate (water) while preventing the loss of steam. If the trap leaks by, then steam will be wasted, reducing system efficiency; and if it fails to operate, water will accumulate. The danger associated with inoperable or defective steam

traps is the potential for condensate-induced water hammer. Steam traps must be of rugged construction and have few moving parts. System start-up provides the greatest potential for trap failure because of the large quantities of condensate generated during system warming, the potential for a slug of condensate containing debris to enter the trap, and the accumulation of air (binding) in the trap. Following is a discussion on three basic types of traps.

- The inverted-bucket trap works on the principle that when a bucket is filled with steam, it is buoyed up in the water, maintaining a valve closed. When water enters the bucket, it displaces the steam, causing the bucket to lose its buoyancy and drop. This opens a valve, allowing the water to be discharged. The cycle repeats as steam re-enters the bucket and buoyancy is restored.
- The float-actuated trap works on the principle that when water accumulates in the trap a float will rise, opening a valve to discharge the water. After the water has discharged, the float drops, closing the valve and preventing steam from escaping.
- The impulse steam trap works on the principle that hot water under pressure will flash to vapor when the pressure is reduced. When hot water enters the trap, pressure is reduced in a control chamber. This causes a valve to open, discharging any water from the trap. When steam enters the trap, pressure in the control chamber increases, closing the valve.

The proper operation of steam traps is important for the safe and efficient operation of process and heating steam systems. DOE/EH-0560, Safety Notice 98-02, *Water Hammer*, recommends (1) walking down steam systems and checking for proper location, distribution, and sizing of steam traps, (2) inspecting steam traps frequently for proper operation, and (3) verifying traps are on-line during system start-up and during system operation. Operators at the West Valley Site check steam trap operation frequently and use thermal imagery (infrared heat gun) to help verify proper operation. The Safety Notice on water hammer can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety Notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: inspection, operation, steam trap

FUNCTIONAL AREAS: Mechanical Maintenance, Operation, Procurement

2. LASER EYE EXPOSURE

This week, OEAF engineers reviewed two recent occurrences involving laser eye exposures. On December 10, 1998, at the Sandia National Laboratory, a graduate student received an eye exposure to a diffused Class IV laser. Neither the laser operator nor the graduate student was wearing eye protection. The graduate student reported having blurred vision and seeing black spots. Physicians did not detect signs of damage in their initial evaluation. A retinal specialist will conduct a follow-up exam to determine if the graduate student's eye is permanently damaged. On December 22, 1998, at the Lawrence Livermore National Laboratory, an experimenter was aligning a laser and his eye was injured when exposed to a stray reflection from the laser. Lasers pose a hazard to the retina, cornea, and lens of the eye. (ORPS Reports ALO-KO-SNL-9000-1998-0010 and SAN--LLNL-LLNL-1998-0065)

At Sandia National Laboratories, a laser was being operated so that the operator and graduate student could install a laser transport tube. The transport tube is a clear, plastic tube that is intended to prevent the direct and diffuse viewing of the beam. Investigators determined that

neither the laser operator nor the graduate student had the required Sandia Laboratories laser safety training but that both were experienced with lasers and were familiar with safe laser operating practices. The graduate student opened a parts box on the laser table and the lid of the box interrupted the beam. Investigators determined that the graduate student received a diffuse exposure to his eye as a result of the beam scattering off the parts box lid. Investigators determined that the laser operator and the graduate student were not wearing eye protection because they needed to observe the beam to properly install the laser transport tube. The facility manager shut down the laser laboratory until investigators complete a root cause analysis and develop corrective actions.

At Lawrence Livermore National Laboratories, the experimenter was aligning a laser when his eye was exposed to a stray reflection from the laser beam. Investigators estimate that the experimenter received 2 to 3 millijoules in a 10 nanosecond pulse. Physicians have determined that there is eye injury, but do not know the extent. The laser laboratory manager directed that the laboratory where the experimenter was injured be locked and posted for authorized entry only and that power to the equipment be locked out. An incident analysis team will conduct further investigation.

NFS reported laser safety violations that resulted in eye exposures in past Weekly Summaries. Following are some examples.

- Weekly Summary 97-47 reported that experimenters at the Ames Laboratory left a Class IIIB laser operating unattended in violation of laboratory laser safety requirements. A laser safety officer who entered the room where the laser was operating reported that his eyes may have been exposed to the beam. A physician examined the safety officer's eyes and detected no damage. Investigators determined that the operator had not taken the mandatory laser and high-voltage safety training. They also determined that the operator should have performed the operation with the door closed, but he propped the door open for convenience. (ORPS Report CH--AMES-AMES-1997-0003)
- Weekly Summary 96-48 reported that a security technician at Lawrence Livermore Site was hit in the eyes by the reflected beam from an operating Class IIIB laser when he entered a room to work on an interlock status panel. Investigators determined that a lead experimenter had left the laser on overnight in violation of laboratory laser safety requirements. An ophthalmologist determined that there was no injury to the experimenter's eye. (ORPS Report SAN--LLNL-LLNL-1996-0060)

OEAF engineers reviewed the ORPS database for other occurrences involving laser safety violations resulting in eye exposures and found one occurrence report describing an event at Sandia National Laboratory–Livermore. In this event, a Sandia employee was attempting to align an unfocused beam from a Class IIIB laser when a stray beam from an optic polarizer he was holding glanced onto his face. An ophthalmologist determined that there was no injury to the employee's eye. (ORPS Report ALO-KO-SNL-CASITE-1997-0001)

These occurrences highlight the need for stringent safety practices when working with lasers. When personnel must work near open laser beams, extra precautions should be made to avoid scattering the beam, especially when working with Class IV lasers. If the option is available, such lasers should be operated at reduced power levels when there is a risk of eye exposures.

Managers of facilities using lasers should ensure that experimenters understand hazard controls unique to laser operations. Training should include information from ANSI Z136.1-1993, American National Standard for the Safe Use of Lasers. This standard provides guidance for the safe use of lasers and laser systems by defining hazard control measures for each of the four laser classifications. Control measures include (1) engineering controls, such as beam

housings, beam shutters, and attenuators; (2) administrative controls, such as procedures, warning signs, labels, and training; and (3) personal protective equipment, such as eyewear, gloves, and special clothing. This standard is endorsed in part by DOE O 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, paragraph 12, "Contractor Requirements Document."

ANSI Z136.1-1993 laser hazard classifications are used to signify the level of hazard inherent in a laser system and the extent of safety controls required. Lasers are grouped into four classes, from Class I (the least hazardous) to Class IV, which is the most hazardous. Complete definitions for each class are contained in ANSI Z136.1-1993.

The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over hazards associated with a job. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the *Hazards and Barrier Analysis Guide* is available by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Road, Germantown, MD 20874.

KEYWORDS: industrial safety, laser, training and qualifications

FUNCTIONAL AREAS: Research and Development, Industrial Safety, Training and Qualification

3. ELEVATED EXPOSURES TO HAZARDOUS MATERIALS

NFS reviewed two recent occurrences at the Sandia National Laboratory involving elevated exposures of employees to hazardous metals. On December 2, 1998, industrial hygienists reported that two Area 10000 Balance-of-Plant employees had received exposures to cadmium and lead fumes or dust that exceeded OSHA Permissible Exposure Levels (PELs). The cadmium exposure was 4.5 times the PEL and the lead exposure was 1.5 times the PEL based on analysis of breathing zone air samples. The employees were using a torch to cut metal that had been excavated from a waste landfill. On December 16, 1998, industrial hygienists reported that an Area 6000 Balance-of-Plant radiation protection technician had been exposed to cadmium dust at twice the PEL. They based their report on their analyses of breathing zone samples taken on December 10. The technician had been surveying materials removed from a waste landfill and sweeping dust from shelves in his area. Exposure to cadmium or lead can have serious acute and chronic health effects. (ORPS Reports ALO-KO-SNL-10000-1998-0006 and ALO-KO-SNL-6000-1998-0006)

Investigators for the occurrence at Area 10000 determined that the employees were wearing personal protective equipment suitable for general industrial hazards but were not wearing protective equipment specific to fumes generated by thermal cutting of cadmium or lead. They were not wearing respiratory protection equipment. Investigators could find no evidence that planners had considered fume hazards in advance. Industrial health personnel monitored the work, but work controls did not specifically require them to be present. The facility manager has suspended all thermal cutting operations until facility personnel can implement effective controls for personnel safety.

Investigators for the occurrence at Area 6000 determined that the dust removal task had been monitored at least twice in the past, with results below the PELs for hazardous metals. They believe that the elevated cadmium levels may have been caused by dust raised by dry sweeping of the shelving rather than wetting it down before cleaning. Work controls did not require the technician to wear respiratory protection equipment. As an immediate corrective action, the facility manager ordered supervisors to revise work procedures to require full-face respirators during dust-removal operations and to require technicians to use a high-efficiency particulate air

vacuum cleaner to remove dust from countertops and shelves. He also ordered industrial hygienists to conduct breathing zone monitoring until confidence is established in revised engineering controls.

OEAF engineers searched the ORPS database and identified several instances where work planning or performance deficiencies have resulted in elevated exposures to hazardous substances. The following are some examples.

- NFS reported in Weekly Summary 98-42 that industrial hygienists at the Idaho Waste Experimental Reduction Facility determined that two workers had been exposed to airborne cadmium dust at levels that exceeded the protection factor for the respiratory protection equipment they were using. The individual workers could have been exposed to as much as 1.16 and 2.68 times the PELs for cadmium dust of 5 µg/m³. The workers were cleaning and inspecting an incinerator off-gas heat exchanger following a test burn for equipment qualification. Metallic cadmium was one of the materials injected before the cleaning and inspection activity. Although facility operators had encountered cadmium dust above the PEL in the heat exchanger during past cleanings, engineers did not expect the very high levels encountered during this task. The facility manager directed facility personnel to revise the Lead and Cadmium Compliance Plan to require a more protective respirator and also to develop more effective engineering and administrative controls to mitigate cadmium hazards. (ORPS Report ID--LITC-WERF-1998-0007)
- At the Kirtland Office Inhalation Toxicology Research Institute, a field technician was exposed to airborne respirable lead slightly above the PEL. The technician was wiping lead shielding to remove dust and oxidation. Investigators determined that work conditions differed from those that work planners had anticipated based on an evaluation of information related to handling of lead bricks in 29 CFR 1926, Lead Exposure in Construction. They believe that this interim final standard may not have considered oxides of lead or the effects of lead cleaning and sweeping activities. Workplace monitoring provided early detection and mitigation of the excursion in lead levels. Facility supervisors revised work procedures to require respiratory protection until they could validate the effects of additional engineering controls. (ORPS Report ALO-KO-ITRI-LOVELACE-1995-0003)
- At the Savannah River Heavy Water Facility, a construction employee inhaled hydrogen sulfide fumes released from a pipe that had been cut with a natural gas torch. The employee was transported to the site medical facility and from there to a local hospital. He experienced nausea, dizziness, and vomiting, and his condition deteriorated rapidly. He then responded dramatically to emergency room treatment for hydrogen sulfide poisoning. Investigators believe that burning and smoldering of material deposited in the pipe by legacy processes had released carbon disulfide and carbonyl sulfide vapors. Carbonyl sulfide converts to hydrogen sulfide in the human body. Investigators determined that work planners had considered the hazards presented by asbestos, hydrogen sulfide gas, combustible gases, and lead but had not adequately considered the effects of deposits on the pipe walls. (ORPS Report SR--WSRC-HWFAC-1993-0003)

Acute exposure to cadmium can cause acute pulmonary edema or death, and chronic exposures can cause kidney damage and lung or prostate cancer. Acute lead exposure may result in seizures, coma, and death from cardiorespiratory arrest. Chronic lead exposure may result in severe damage to blood-forming, nervous, urinary, and reproductive organs. Inhalation is the primary means of taking lead or cadmium into the body, although either may also be absorbed through the digestive tract.

These events underscore the importance of performing a thorough activity hazard analysis for all jobs, including those that are commonplace or repetitive. It is often difficult or impossible to measure concentrations of airborne contaminants in real time. Analysis of breathing zone samples may require up to several days to complete. Samples of an atmosphere or surfaces before work begins are generally unreliable indicators of the contamination that could be introduced as work progresses. Uncertainties surrounding contamination levels that could be encountered during work dictate highly conservative approaches to work planning and to selecting and using respiratory protection equipment. Industrial hygienists and work planners should review the following guidance.

- DOE 440.1A, Worker Protection Management for DOE Federal and Contractor Employees, requires all DOE elements to identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness. The Order also requires DOE elements to assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation.
- 29 CFR 1910.1000, Airborne Contaminants, states that whenever feasible, compliance with exposure limits for airborne contaminants must be achieved by determining and implementing administrative or engineering controls. If administrative or engineering controls are not feasible to achieve full compliance, protective equipment or other protective measures must be used to keep the exposure of employees to air contaminants within prescribed limits.
- 29 CFR 1910.134, Respiratory Protection, states that whenever respirators are required to protect the health of the employees, the employer must establish and implement a written respiratory protection program with worksite-specific procedures. The program must be updated as necessary to reflect changes in workplace conditions that affect respirator use. The standard also states that when employers cannot identify or reasonably estimate the employee exposure, they must consider the atmosphere immediately dangerous to life and health, which requires use of a full-face, pressure-demand, self-contained breathing apparatus or supplied-air respirator with an auxiliary self-contained air supply.

When exposure to cadmium is expected, work planners should also review 29 CFR 1910.1027, Cadmium, for information to develop work plans and monitoring programs. The standard states that if initial monitoring reveals employee exposures to be at or above the PEL, the employer must monitor at a frequency and pattern needed to assure the adequacy of respiratory selection and the effectiveness of engineering and work controls. 29 CFR 1926.62, Lead, applies to employees who may be occupationally exposed to lead. The regulation states that the employer must ensure that no employee is exposed to lead at concentrations greater than 50 $\mu g/m^3$ of air averaged over an 8-hour period. The regulation also states, in part, that until an employer performs an exposure assessment, it must treat the employee as if the employee were exposed above the PEL and must implement protective measures that include respiratory protection, awareness training, and blood sampling.

OSHA standards are available at the OSHA website, http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc.html.

KEYWORDS: hazard analysis, industrial hygiene, respirator, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

4. RADIOGRAPHY CONTROL VIOLATION RESULTS IN OVEREXPOSURE

This week OEAF engineers reviewed a recent Nuclear Regulatory Commission (NRC) event where a contractor employee received an estimated whole body exposure of 50 rem and 600 to 1700 rem to his extremities when he dislodged a 60-Ci iridium-192 source from its guide tube and then attempted to reassemble it. On December 16, 1998, a Professional Service Industries Inc. (PSI) radiographer was performing radiography when he noticed that the contractor employee had dislodged the source and was attempting to reassemble it, so he shouted a warning for the contractor employee to stop and cranked the source back into the collimator. The radiographer then notified the appropriate personnel and suspended radiography operations. PSI personnel began an investigation and notified state radiation control program personnel. State radiation control program personnel will also investigate this event. Failure to control the source caused the contractor employee to receive a significant dose in a very short time. (NRC Event Number 35164)

Radiography technicians were performing a series of 2-minute radiography shots of a parking garage ceiling when this event occurred. One radiographer was assigned to monitor the floor directly above the radiography area while a second radiographer performed the radiography. Two contractor employees were inside the parking garage with the second radiographer while he was performing radiography. Investigators have not determined why the contractor employees were permitted in the area during the radiography or how they entered the area. The second radiographer was talking to the contractor employees when one of the contractor employees walked toward the source collimator, dislodged it from the source guide tube, and then attempted to reassemble the source and the guide tube.

OEAF engineers searched the NRC database and found two Notice of Violations issued to PSI for similar events. On February 28, 1997, NRC personnel issued a Notice of Violation to PSI for failure to follow radiation safety procedures to secure or maintain surveillance of material because an NRC-licensed material device was left unsecured and uncontrolled in an unrestricted area. Investigators determined that a lack of effective training caused this event. On May 22, 1997, NRC personnel issued a Notice of Violation to PSI for circumstances relating to an apparent radiation overexposure of a technician. Investigators determined that a lack of management oversight and attention to radiation safety program implementation had contributed to the event. They also concluded that although PSI's training and radiation safety programs were procedurally in place, no one effectively implemented them. (NRC Enforcement Actions 96-490 and 97-093 and NRC Augmented Inspection Team Report Nos. 030-315533/96-02 and 45-25088-01/96-01)

NFS has reported similar events involving inadequate radiological controls in several Weekly Summaries. Following are some examples.

• Weekly Summary 98-25 reported two events where personnel did not adhere to established radiography control requirements. In the first event, a facility operator at the Savannah River Site entered a barricaded area where radiography was being performed because he incorrectly assumed that he was able to pass through the barricaded area without an escort. In the second event, researchers at the Los Alamos National Laboratory Pajarito Laboratory failed to make proper notifications, post an exclusion area, or activate warning lights before conducting a radiography experiment, resulting in two security officers receiving a potential unattenuated dose of approximately 1 mrem. Investigators determined that the researchers had failed to follow the procedure for the experiment. (ORPS Report SR--WSRC-TRIT-1998-0007 and ALO-LA-LANL-TA18-1998-0006)

- Weekly Summary 95-06 reported two events involving improper personnel entries into radiography areas. At the Los Alamos National Laboratory, an employee misinterpreted a posting and entered a radiography exclusion area in violation of posting requirements. The employee could have received a dose of approximately 200 mrem if the radiography equipment had been operating while he was in the area. At the Savannah River In-Tank Precipitation Facility, a tank operator entered a radiography area to operate equipment. Facility personnel determined that the barricade was inadequate and allowed access to the radiography area through an unbarricaded entrance point. (ORPS Reports ALO-LA-LANL-TRITFACILS-1995-0002 and SR-WSRC-ITP-1995-0003)
- Weekly Summary 94-12 reported that an operator at the Savannah River Site violated a radiological controls barricade when he entered an area while radiography was in progress. The radiography boundary was not consistent with normal Savannah River radiological boundary practices. Investigators determined that the site did not have a radiological procedure to govern radiography work. (ORPS Report SR--WSRC-FCAN-1994-0019)
- Weekly Summary 92-23 reported that a worker at the Savannah River Site passed through an emergency door exit and into a room where radiography was in progress. Investigators determined that the emergency door was not properly posted and that the worker had not been informed that radiography would occur in the room and did not hear a public address announcement that radiography was in progress. (ORPS Report SR--WSRC-REACK-1992-0211)

NFS also reported in Weekly Summary 93-37 on three events involving unauthorized entries into radiography areas at commercial nuclear power plants, as detailed in NRC Information Notice 93-69, *Radiography Events at Operating Power Reactors*, September 2, 1993.

Events involving loss of administrative control during radiography are significant because radiography sources can create extremely high radiation fields in which allowable dose limits can be exceeded in a short time. These events underscore the importance of good communication and verification that radiography exclusion areas are completely barricaded, clearly marked, and cleared of personnel. Exceptions to procedures and controls should not be made, because they can lead to misunderstanding and a diminished respect for barriers to hazards. Although doses to personnel were insignificant in some of these events, more serious exposures could have occurred if the timing had been different or if personnel had been closer to the radiography source.

Facility managers should ensure that employees understand their responsibility for complying with procedures and observing postings and barricades established for radiography. Facility managers and radiation protection managers should ensure that radiological procedures are complete and accurate. They should also ensure that facility personnel are fully briefed about radiography activities that may be performed at a site or facility and on the steps employees should take to avoid unplanned exposure.

Facility and radiation protection managers at facilities where radiography may occur or other radiation-generating devices may be operated should review their facility program compliance with the following articles in DOE/EH-0256T, DOE Radiological Control Manual, Part 1.

Article 365, "Radiation Generating Devices," specifies the requirements related to
operation and control of radiation generating devices. It requires stringent physical
and administrative control of radiography sources to prevent overexposure to
operating and support personnel and to personnel in adjacent work areas. Article
365 incorporates related requirements by reference to the following documents: (1)
DOE O 5480.4, Environmental Protection, Safety, and Health Protection Standards;

- (2) ANSI N43.3, American National Standard for General Radiation Safety Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10MeV; (3) ANSI N43.2, Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment, and (4) 10 CFR 34, Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations.
- Article 655, "Radiographers and Radiation-Generating Device Operators," contains training and qualification requirements for radiographers and radiation-generating device operators. It states that radiographers should be trained in accordance with 10 CFR 34.31 and that radiation-generating device operators should have training appropriate for the radiation source involved and commensurate with the level described in 10 CFR 34.31. Article 655 incorporates related requirements by reference to DOE O 5480.4, Environmental Protection, Safety, and Health Protection Standards, which mandates the use of ANSI N43.3, American National Standard for General Radiation Safety Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, for operations involving the irradiation of materials.

KEYWORDS: barricade, exclusion area, radiography, posting

FUNCTIONAL AREAS: Training and Qualifications, Radiation Protection, Procedures

FINAL REPORT

This section of the OE Weekly Summary discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. FLAMMABLE LIQUID FIRE AND EXPLOSION AT FERMILAB

This week OEAF engineers reviewed a Type B investigation report about a fire and explosion at Fermi National Accelerator Laboratory (Fermilab). A vapor flash-explosion ignited combustible materials and burned three subcontractor service employees while they were cleaning a concrete floor. An area sprinkler system activated and extinguished the fire. Fire department personnel responded to the scene and sent all three employees to off-site medical facilities. Medical personnel treated two of the subcontractor service employees, a foreman and a painter, for first-and second-degree burns and released them. They transported a second painter to a facility with a burn unit, where he was hospitalized in fair condition. Laboratory personnel secured the accident area. The DOE Chicago Area Office (DOE-CH) assembled a Type B Accident Investigation Team to investigate the event. (ORPS Report CH-BA-FNAL-FERMILAB-1998-0004 and OEWS 98-32)

The subcontractor service employees were using a floor-buffing machine to strip a floor in an enclosed dry storage room to prepare it for painting. Investigators learned that the contractor foreman had misunderstood verbal instructions to order muriatic acid and had instead ordered muriatic "acetone." The supplier substituted acetone, which the foreman did not notice when he picked up the materials. After they had finished cleaning the floor with an industrial cleaner and degreaser, the foreman determined that the floor needed further cleaning and sent one of the painters to get the "muriatic acid." The painter returned with a case containing four one-gallon cans of acetone instead, which the foreman decided to use after attempting to contact the contractor project manager by cellular telephone. The manner in which workers used the acetone is unclear. One of them accidentally spilled a container of acetone and began to clean it up while another worker continued buffing the floor. As the foreman was helping to clean up the spill with a

mop and water, a second can of acetone was knocked over and spilled. An explosion occurred as the foreman was leaving the room with a bucket of acetone/water mixture. He reported that the explosion slammed the door of the room shut and ignited the bucket he was carrying. The foreman received a slight first-degree burn to the lower left forearm. The painter who was operating the buffer ran from the room first with the back of his shirt on fire. He suffered first- and second-degree burns to 20 percent of his body. The second painter reported that the floor surrounding him was in flames. He escaped the room with flames on his face. This individual suffered second- and third-degree burns to 33 percent of his body. He required skin graft surgery and was hospitalized for approximately two weeks. The force of the explosion moved a cinder block wall approximately one inch at its top and damaged and dislodged ceiling tiles in adjoining spaces.

Investigators concluded that two separate hazards were involved in this occurrence. The first was the health hazard when workers were exposed to acetone vapors above the permissible exposure limit. The second was the physical hazard when acetone vapors exceeded the lower explosive limit

The direct cause of the incident was the ignition of a flammable mixture of acetone vapors in air. The floor-buffing machine is the most likely ignition source, although other ignition sources are possible. Investigators identified as the root cause failure of the subcontract service employees to recognize the hazards of using acetone to clean the storage room floor. The contractor should have ensured that the painters were properly trained to recognize the hazards of flammable liquids, such as acetone, methyl ethyl ketone, and paint thinners, so that they could implement adequate control measures. Acceptable controls include, but are not limited to, substituting a less hazardous material, limiting the quantity of acetone used, providing adequate ventilation, eliminating ignition sources, providing continuous explosive vapor monitoring, and following spill response procedures. As a systemic root cause, investigators identified failure by managers to adequately implement Integrated Safety Management System core functions related to definition of work scope, hazard analysis, and development and implementation of controls. The Fermilab project manager and the contractor project manager did not integrate their efforts to define the work scope, conduct the hazard analysis, and develop work controls. This resulted in differences in understanding of how the work was to be performed and controlled. DOE-CH and Fermilab did not institute a comprehensive Integrated Safety Management System that applied to all activities.

Investigators also identified the following contributing causes, which collectively increased the likelihood of the occurrence.

- Work planning was inadequate for the work the painters were engaged in at the time of the accident. Because of the size of the painting job, work planners considered it routine and all personnel involved treated it informally.
- Work controls were not adequately defined and communicated to the contractor employees. Work planners did not adequately define job personal protective equipment and respirator requirements or communicate them to the contractor employees. They did not identify the need for adequate ventilation in connection with the use of floor preparation chemicals and epoxy paint. Workers did not wear gloves while they were cleaning the floor, and the air- purifying respirators they used were inadequate for the chemical hazards created by the work.
- Fermilab failed to implement a fully integrated process to ensure that work planners give adequate consideration to environment, safety, and health (ES&H) issues for jobs that involve the use of hazardous substances. Neither Fermilab nor the contractor requested ES&H technical support to evaluate work hazards or to formulate appropriate control measures.

- Fermilab did not inform the contractor project manager and foreman of work controls contained in the contract or in applicable Fermilab ES&H procedures. Investigators determined that the contractor failed to implement key safety provisions in the contract dealing with approval of hazardous materials, fire safety, personal protective equipment, and reporting of spills of hazardous materials.
- Fermilab did not provide training for the contractor employees or ensure that they had adequate knowledge to perform the work safely. It could not provide evidence to investigators that the contractor employees had received job-specific training in Fermilab ES&H procedures and contract provisions applicable to the work. Neither Fermilab nor the contractor could provide evidence to investigators that contractor personnel were knowledgeable and trained in the use of hazardous chemicals or in the use of personal protective equipment and respirators.
- Fermilab did not provide adequate oversight of contractor work activities. It did not
 identify the lack of adequate ventilation, personal protective equipment, and
 respirators, which were needed to perform the work safely.
- Fermilab did not use information from previous accident investigations and assessment reports to ensure continuous improvement in defining and planning contractor work. The Board reviewed a previous Type B accident investigation report, Electric Arc Blast in October 1997, and an investigation into a contractor employee concern. Both reports cited a lack of Fermilab planning and hazard analysis as contributing causes. An August 1997 Assessment Report, Fermilab's Triennial Assessment of Integrated Safety Management, identified a deficiency in the area of formality of operations. Investigators did not find any improvements in work planning or hazard analysis that would indicate an adequate feedback process for continuous improvement.

In addition, investigators concluded that DOE-CH needs to conduct a comprehensive review of operations and administration at Fermilab to ensure adequate implementation of the five core functions of the Integrated Safety Management System.

The complete report of the Type B Accident Investigation Board is available on the web at http://nattie.eh.doe.gov:80/oversight/acc_inv.html.

KEYWORDS: injury, Type B Investigation, burn

FUNCTIONAL AREAS: Industrial Safety, Lessons Learned

OEAF FOLLOW-UP ACTIVITY

1. CORRECTION TO WEEKLY SUMMARY 98-50, ARTICLE 7

Article 7, "Box of Infectious Waste Mistaken to Contain Recycled Lightbulbs" in Weekly Summary 98-50 requires the following corrections and clarifications. The article and its title should have stated that the box contained "potentially" infectious waste. The radiological control technicians used the cardboard box to contain blood droppings while tending to the mechanic's wound. The reference a "recycling facility" should have been a "recycling storage area at Los Alamos National Laboratory." And finally, storage of the box in the less-than-90-day storage area (although not considered a normal practice) was not done incorrectly, as stated in the article.

KEYWORDS: hazardous material, labeling, packaging, radiation protection, waste

FUNCTIONAL AREAS: Materials Handling/Storage, Radiation Protection, Transportation and

Packaging

PRICE-ANDERSON AMENDMENTS ACT (PAAA) INFORMATION

1. PRELIMINARY NOTICE OF VIOLATION AND PROPOSED CIVIL PENALTY FOR BIOASSAY PROGRAM AND RADIOLOGICAL CONTROL DEFICIENCIES

On November 16, 1998, the DOE Office of Enforcement and Investigation issued a Preliminary Notice of Violation and proposed a \$165,000 civil penalty under the Price-Anderson Amendments Act to Babcock & Wilcox of Ohio, Inc. (BWO) for significant deficiencies in its radiological work controls, its bioassay program, and corrective actions. The Office of Enforcement and Investigation conducted the investigation and determined that the deficiencies reflected a management failure across several organizations responsible for the safe operation of the Mound site. Investigators stated that they were particularly concerned because the proposed violations and deficiencies were not isolated events and because significant Mound bioassay program deficiencies continued to go uncorrected despite the issuance of civil penalties to the previous contractor and significant DOE attention over the last several years. (NTS-OH-MB-BWO-BWO04-1998-0001, NTS-OH-MB-BWO-BWO04-1998-0002, and NTS-OH-MB-BWO-BWO06-1998-0001; Letter, DOE (P. Brush) to Babcock & Wilcox of Ohio, Inc. (P. Baker), 11/16/98)

The Office of Enforcement and Investigation staff identified multiple deficiencies and classified them as Severity Level II violations in the Preliminary Notice of Violation. Severity Level II violations are significant violations that demonstrate a lack of attention or carelessness toward safety that could potentially lead to adverse impacts. Investigators determined that these deficiencies represent potential violations of 10 CFR 830, *Nuclear Safety Management*, and 10 CFR 835, *Occupational Radiation Protection*. The Notice describes violations that involved (1) exhaust ventilation system pre-filter replacement deficiencies and (2) internal dose evaluation program failures.

EXHAUST VENTILATION SYSTEM PRE-FILTER REPLACEMENT VIOLATIONS

Investigators determined that numerous work planning and work conduct deficiencies involving a pre-filter replacement event and the initial response to this event caused workers to be unknowingly exposed to radiological conditions that exceeded the protection factor of their respiratory protection by a factor of 2 to 5. Workers were exposed to a significant increase in airborne radioactivity and one worker received an uptake equivalent to 10 mrem committed

effective dose equivalent. Investigators determined that facility personnel failed to notify the worker who received the uptake that he was restricted from radiological work until 6 days after his restriction period began. Investigators stated that "no evidence of pro-active self-identification of the deficient areas was identified, despite a number of opportunities that existed for management to self-identify these problems during the work planning and approval process and correct the deficiencies before the work was performed." Two civil penalties were proposed totaling \$110,000 (\$55,000 for each proposed violation) for the following three proposed violations.

- No one monitored the pre-job radiological conditions in the pre-filter replacement work areas and no one verified that engineering and process controls would contain radioactive material and reduce radiation exposures.
- No one performed an as low as reasonably achievable review to determine if the radiological work planning for the pre-filter replacement work was appropriate, workers did not follow administrative controls and procedure requirements, and managers did not adequately review work control documents before workers used them.
- No one used appropriate air monitoring equipment during the pre-filter replacement work, and the air monitoring equipment that was used was inadequate to estimate airborne radioactivity levels in a real-time manner. Furthermore, no one realized until 2 weeks later that the job airborne radioactivity levels had exceeded three radiological work permit stop-work conditions.

INTERNAL DOSE EVALUATION PROGRAM VIOLATIONS

Investigators identified continuing problems with Mound's internal dose evaluation program and stated that these problems occurred because of "a continuing culture of non-adherence to established bioassay program requirements." They also stated that a "clear lack of communication between the Radiobioassay Laboratory analytical function and the Dose Assessment function as well as failure to understand the implications to the workers when the bioassay program did not fulfill its obligations exists." Investigators proposed two civil penalties totaling \$55,000 (\$27,500 for each proposed violation) for the following four proposed violations.

- No one ensured (1) that the bioassay services were continuous, (2) that the bioassay sample cycle times were met, and (3) that timely notifications of positive bioassay results were provided to workers.
- No one formally controlled the design interfaces between the vendor software and the site database.
- No one adequately implemented site quality improvement processes for the bioassay program.
- No one ensured that management tools (such as internal audits) adequately identified and corrected bioassay program deficiencies.

Babcock & Wilcox of Ohio, Inc., management has replied to the Preliminary Notice of Violation and Proposed Imposition of Civil Penalty and admitted the alleged violations. Enforcement actions can be found at the Office of Enforcement and Investigation website at http://tis-nt.eh.doe.gov/enforce/.

NFS has reported recent Notices of Violations under the Price-Anderson Amendments Act in Weekly Summaries 98-49, 98-42, 98-41, 98-40, 98-26, 98-15, and 98-11.

Under the provisions of the Price-Anderson Amendments Act, DOE can fine contractors for violations of Department rules, regulations, and compliance orders relating to nuclear safety requirements. DOE contractors who operate nuclear facilities or perform nuclear activities and fail to remain in compliance with such requirements could be subjected to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements*, and/or 10 CFR 835, *Occupational Radiation Protection*. These actions include Notices of Violation and, where appropriate, nonreimbursable civil penalties.

The primary consideration for determining whether DOE takes enforcement action is the actual or potential safety significance of the violation, coupled with how quickly the contractor acts to identify and correct problems. The Office of Enforcement and Investigation may reduce penalties when a DOE contractor promptly identifies a violation, reports it to DOE, and undertakes timely corrective action. DOE has the discretion not to issue a Notice of Violation in certain cases.

The Noncompliance Tracking System (Weekly Summaries 95-17 and 95-20) provides a means for contractors to promptly report potential noncompliances and take advantage of provisions in the enforcement policy. DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, discusses management responsibility for incorporating appropriate corrective actions in a timely manner.

KEYWORDS: enforcement, Price-Anderson Act, quality assurance, radiation protection,

procedures

FUNCTIONAL AREAS: Lessons Learned, Management, Radiation Protection, Procedures